MITSUBISHI HEAVY INDUSTRIES

Centrifugal Chiller

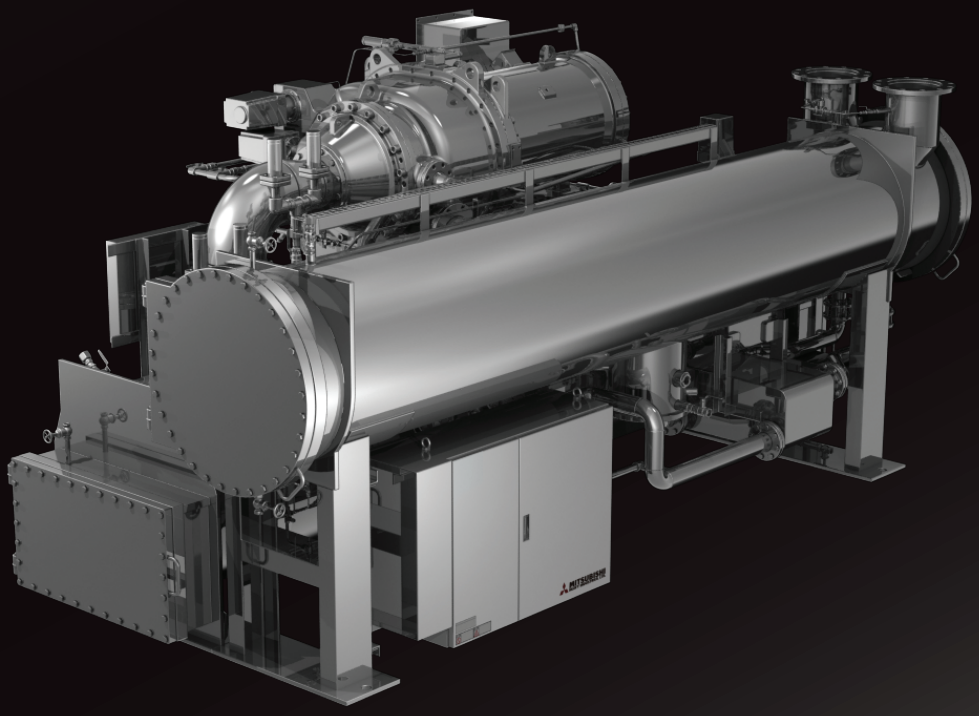
HFC-134a

Constant speed

Variable speed

GART & GART-I series

1934kW(550RT)~18986kW(5400RT)



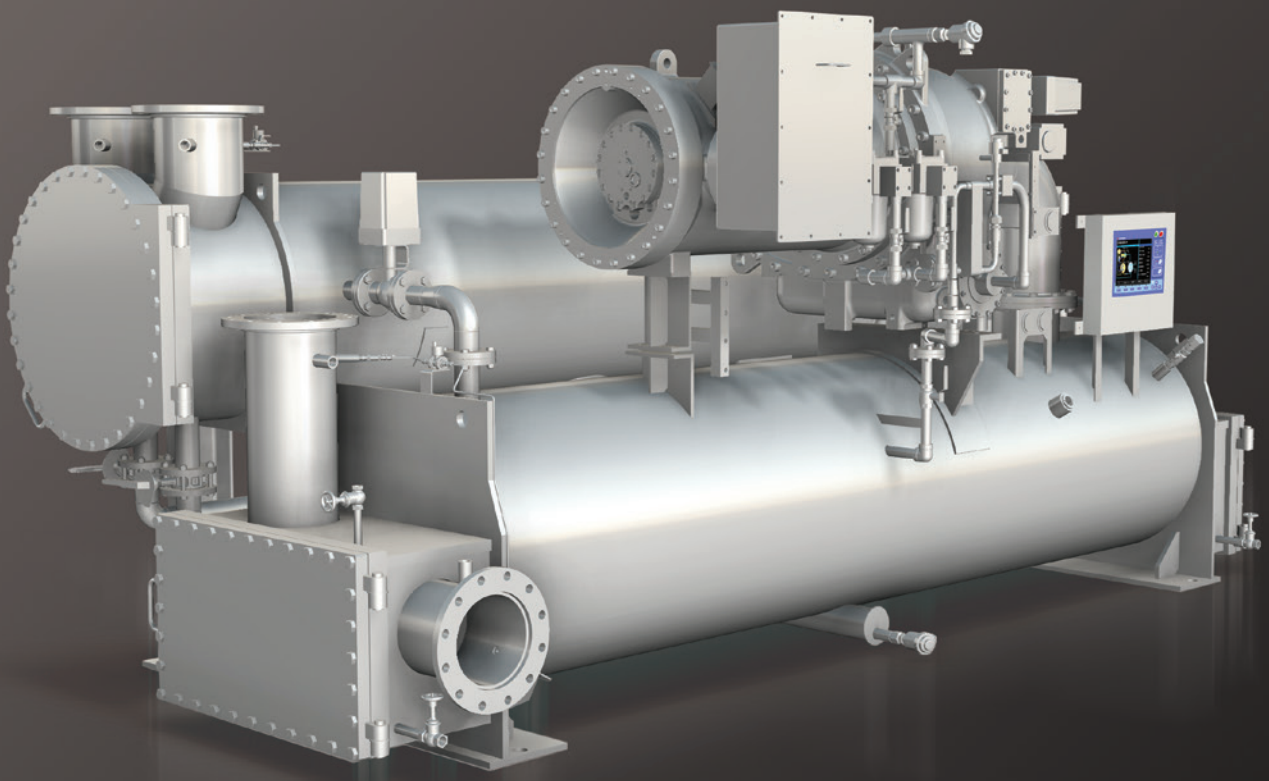
AHRI CERTIFIED®
www.ahridirectory.org
Water-Cooled Water Chilling and
Heat Pump Water-Heating Packages
AHRI Standards 550/590 and 551/591

Centrifugal Chiller

Constant speed　　Variable speed

HFC-134a

GART & GART-I series



				ETI	AART	AART-I	GART-H GART-HI AART-H AART-HI	GART-H.HR GART-H.HR.I AART-H.HR AART-H.HR.I	GART	GART-I
Drive (Variable speed / Constant speed)				Variable	Constant	Variable	Constant/Variable	Constant/Variable	Constant	Variable
Capacity(Chilled Water 12°C/7°C)*1				150-700RT	230-550RT	230-550RT	190-3000RT	210-2500RT	550-5400RT	550-5400RT
Temperature	Chilled Water Leaving		Lower Limit	4°C	3°C	3°C	Minus 5°C Low temp. use	3°C	3°C	3°C
	Cooling Water Entering		Lower Limit	12°C	12°C	12°C	12°C	12°C	12°C	12°C
	Hot Water Leaving	Heat Recovery	Higher Limit	—	—	—	—	50°C	—	—
Load	Control Range in a Constinuous Operation		Standard	100% - 10%	100% - 20%	100% - 20%	100% - 30%	100% - 30%	100% - 20%	100% - 20%
			Option	100% - 0%	100% - 10%	100% - 0%	100% - 10%*2	100% - 10%	100% - 10%	100% - 0%
Flow Rate	Chilled Water / Cooling Water Flow Rate Control Range	Variable Flow Rate	Standard	100%	100%	100%	100%	100%	100%	100%
			Option Notes: Less than 50% is possible depending on model	100% - 50%	100% - 50%	100% - 50%	100% - 50%	100% - 50%	100% - 50%	100% - 50%
	Chilled water Flow Rate Control Range	Excess Flow Rate	Standard	100%	100%	100%	100%	100%	100%	100%
			Option Notes: More 150% is possible depending on model	—	100% - 150%	100% - 150%	100% - 150%	100% - 150%	100% - 150%	100% - 150%

*1 Subject to temp. condition
*2 Control range change subject to temp. condition of brine

Evolution

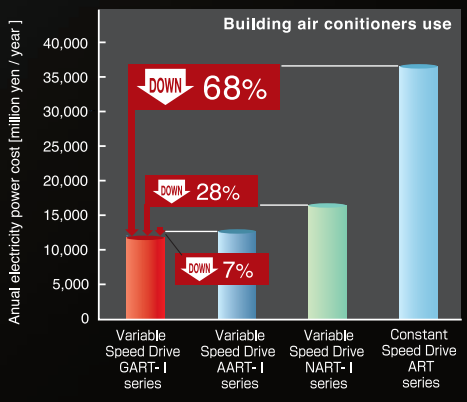
Wide variety of advanced Centrifugal Chiller series. Variable Speed Driven, Low Temperature and Heat Recovery models for medium to high capacity range

GART/GART-I series commit to efficiency improvement in an effort to establish a low carbon society.
-Contributing to environmental load reduction by achieving a performance advance in all operation range and load.

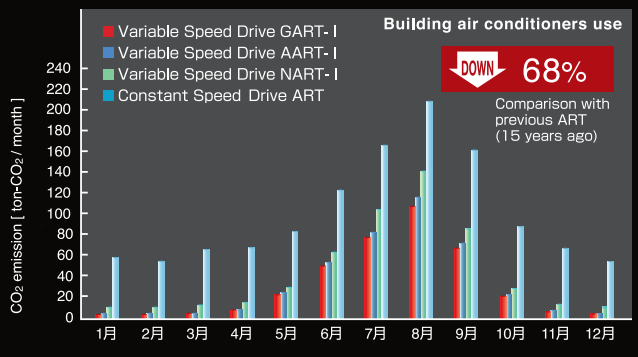
In 2016 year, Low Temperature and Heat Recovery models are newly added to the GART series for further satisfaction of valuable customers.
-Corresponding to wider range of market requirement from different segment.

We keep delivering original and advanced technology for the sustainability and environmental contribution in the world.

Anual Electricity Cost



Anual CO_2 Emission

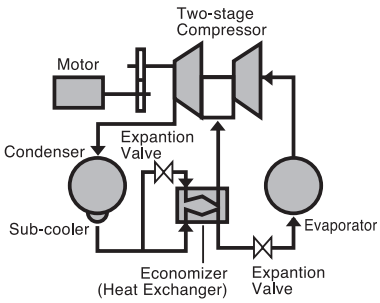


High Efficiency

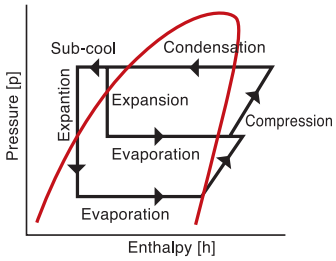
◎Newly shaped compressor impellers

◎Improved evaporators and condensers

◎Adoption of a new **two-stage-compression/ one-stage-expansion/economizer/ sub-cooler cycle** enhanced tracking of load fluctuations



System

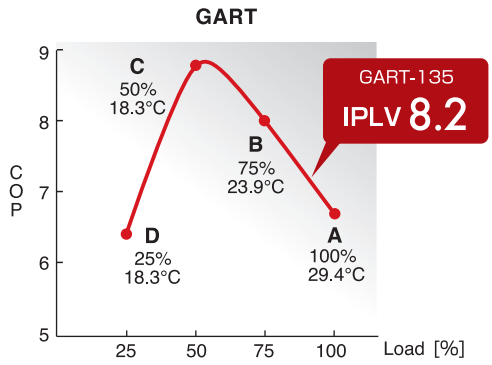


P-h Diagram

Constant speed drive

COP
[AHRI Standard 550/590(I-P)-2011]
7.0
GART-135,190,270

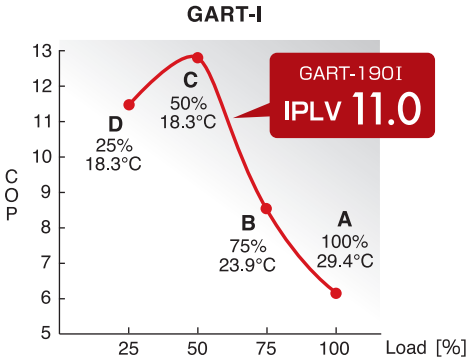
IPLV
[AHRI Standard 550/590(I-P)-2011]
8.2
GART-135

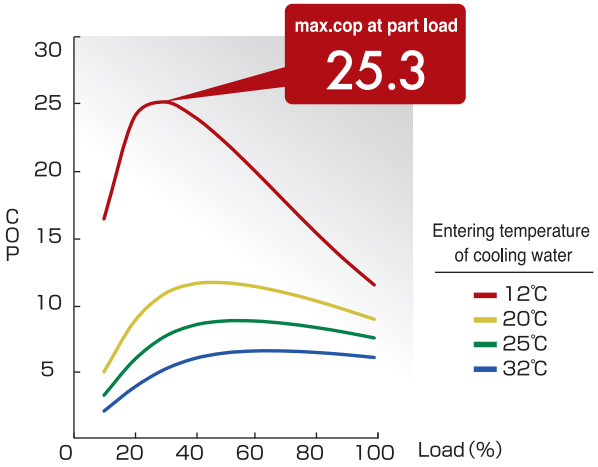


Variable speed drive

Max.**COP** at part load
25.3
GART-190I

IPLV
[AHRI Standard 550/590(I-P)-2011]
11.0
GART-190I





IPLV

IPLV is the formula developed by AHRI to measure the efficiency of chillers under an actual annual operating conditions. IPLV is calculated when the unit is operating at 25%, 50%, 75% and 100% of capacity and at different cooling water temperature.
[AHRI Standard 550/590(I-P)-2011]

IPLV: Integrated Part Load Value
AHRI: Air-Conditioning, Heating and Refrigeration Institute

IPLV = 0.01A + 0.42B + 0.45C + 0.12D
A = COP at 100% load (29.4°C*1) B = COP at 75% load (23.9°C*1)
C = COP at 50% load (18.3°C*1) D = COP at 25% load (18.3°C*1)
Leaving temperature of chilled water: 6.7°C
*1 : Entering temperature of cooling water

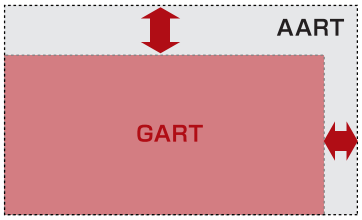
Compact

◎Chiller components are arranged in a way to use vertical space optimally
◎Compressors, evaporators and condensers have been reduced in size
◎Plate type heat exchanger has been introduced in the economizer

Dimensions

approx. **30%** reduction

〈compared to previous model : AART 1000RT〉

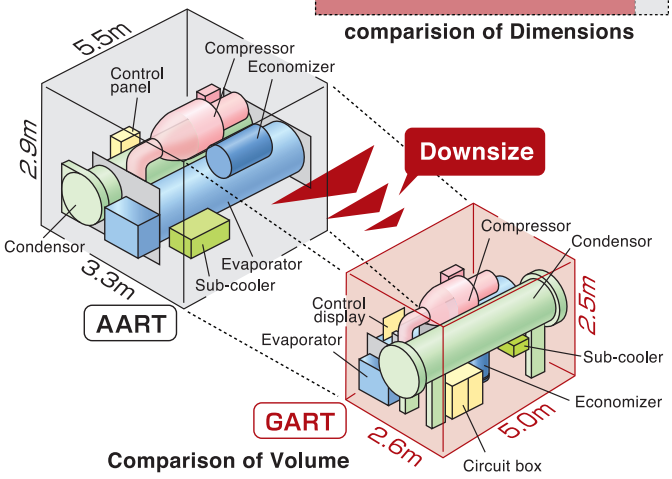


comparision of Dimensions

Volume

approx. **40%** reduction

〈compared to previous model : AART 1000RT〉



Comparison of Volume

Widen max. Cooling Capacity to 6000RT.

◎Single compressor type: to 3000RT, Dual compressor type: 6000RT

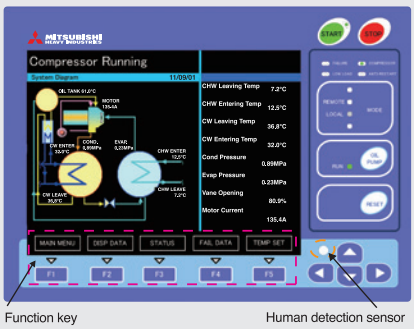
Multifunction Microcomputer Control

Separate off control display and circuit box
Layout of control display is free

Big 10.4 inch Display | Clear Digital Display | Smooth Quick Response (Save Energy)

Liquid Crystal Display (LCD) with automatic lighting-up function
Relight-up by human detection sensor without touching panel

For environmental standards
Realize lead-free substrate
RoHS compliant



Followings are displayed
- Operation data - Failure data
- Real time trend (max. 5 operational data and max. 3 situational data)
- Setup schedule operation condition <OPTION>

Other Features

● **Control Function (Option)**
- Meeting with BAS (Building Automation System) requirement.
- Meeting with control monitoring equipment
- In case of instantaneous power failure, chiller restarts automatically.

● **Reliability**
- Stability of lubrication oil level and oil temperature improved with oil-cooler for refrigerant and high efficient oil recovering system.
- Chillers are produced at our factory certificated authentication ISO 9001 and 14001.

● **Maintenance**
- Overhaul interval is 50,000 hour in operating time or 7 years in elapsed time, which comes earlier.
- Marine type water box with hinge is provided as standard scope of supply for easier maintenance and inspection.

Please contact with MTH* about overhaul.
The above overhaul time and operation time is for reference only.

● **Application to Low Brine Temperature Cooling**
- Applicable for industrial use and ice storage system by adopting two stage compressor.

*MTH: Mitsubishi Heavy Industries Thermal Systems, Ltd.

Standard Ratings

■ AHRI 550/590(I-P)-2011 Condition
Chilled water 12.2°C / 6.7°C, Cooling water 32°C / 37°C

(Rating common to both constant and variable speed)

Item (unit) \ Model		GART-	65 / 65I	75 / 75I	95 / 95I	110 / 110I	135 / 135I	160 / 160I	190 / 190I	225 / 225I	270 / 270I
Cooling capacity		USRt	480	620	750	880	1,030	1.310	1,350	1,770	1,950
		kW	1,688	2,180	2,637	3,094	3,626	4,606	4,747	6,224	6,857
Chilled water	Enterling temperature	°C	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2	12.2
	Leaving temperature	°C	6.7								
	Flow rate	m³/h	263.3	422.0	434.0	555.0	640.0	808.0	929.0	1,134.0	1,255.0
	No. of pass	-	2	2	2	2	2	2	2	2	2
	Pressure drop	kPa	30	55	44	58	52	80	47	75	46
	Piping connection nozle Size	A	250	250	300	300	350	350	400	400	450
Cooling water	Enterling temperature	°C	29.4								
	Leaving temperature	°C	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5	34.5
	Flow rate	m³/h	328.7	425.3	513.4	602.8	697.6	896.6	921.3	1,211.0	1,331.0
	No. of pass	-	2	2	2	2	2	2	2	2	2
	Pressure drop	kPa	45	70	42	57	41	64	36	58	54
	Piping connection nozle Size	A	250	250	300	300	400	400	450	450	500
Insulation area		m²	32	33	39	40	46	48	56	57	72
Motor out put		kW 50Hz	222	289	346	411	467	606	616	826	897
		kW 60Hz	223	291	347	416	454	611	621	835	906
Power source : main		-	400V class / 3kV class / 6kV class			3kV class / 6kV class (Refer to Notes 5)					
Power source : auxiliary		-	Three-phase 200/220 V								
Maxmum cooling capacity		RT	650	750	950	1,100	1.350	1,600	1,900	2,250	2,700

■ JIS B8621:2011 Condition
Chilled water 12°C / 7°C, Cooling water 32°C / 37°C

(Rating common to both constant and variable speed)

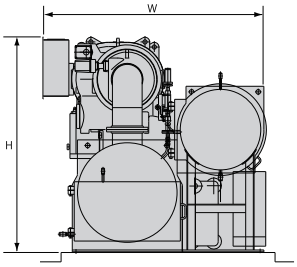
Model		GART-	65 / 65I	75 / 75I	95 / 95I	110 / 110I	135 / 135I	160 / 160I	190 / 190I	225 / 225I	270 / 270I
Cooling capacity		RT	550	700	720	920	1,050	1,340	1,540	1,880	2,070
		kW	1,934	2,461	2,532	3,235	3,692	4,712	5,415	6,611	7,279
Motor out put		kW 50Hz	273	357	357	467	519	673	763	953	1,031
		kW 60Hz	273	358	358	469	526	674	765	961	1,036
Chilled water	Flow rate	m³/h	331.8	422.0	434.0	555.0	640.0	808.0	929.0	1,134.0	1,255.0
	No. of pass	-	2	2	2	2	2	2	2	2	2
	Pressure drop	kPa	44	80	48	75	64	98	69	99	61
	Piping connection nozle Size	A	250	250	300	300	350	350	400	400	450
Cooling water	Flow rate	m³/h	387.7	495.0	507.2	650.1	738.9	945.2	1,083.0	1,327.0	1,458.0
	No. of pass	-	2	2	2	2	2	2	2	2	2
	Pressure drop	kPa	59	88	41	65	45	70	48	68	63
	Piping connection nozle Size	A	250	250	300	300	400	400	450	450	500
Insulation area		m²	32	33	39	40	46	48	56	57	72
Power source : main		-	400V class / 3kV class / 6kV class			3kV class / 6kV class (Refer to Notes 5)					
Power source : auxiliary		-	Three-phase 200/220 V								
Maxmum cooling capacity		USRt	650	750	950	1,100	1,350	1,600	1,900	2,250	2,700
Constant (GART)	Motor input	kW 50Hz	302	393	393	514	568	739	833	1,038	1,119
		kW 60Hz	304	397	397	524	583	750	845	1,061	1,137
	Auxiliary Power	kW	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	COP	50Hz	6.36	6.24	6.42	6.27	6.50	6.36	6.49	6.36	6.50
		60Hz	6.33	6.17	6.35	6.16	6.37	6.27	6.40	6.22	6.42
Variable(GART-I)	IPLV	50Hz	9.14	8.34	8.88	8.45	9.29	8.62	9.29	8.58	9.14

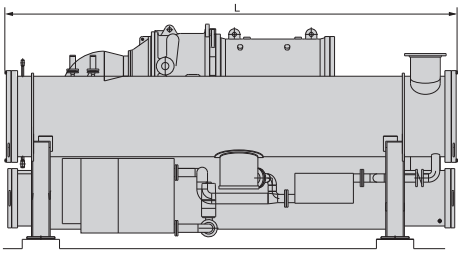
Notes: 1. This specification is based on AHRI STANDARD 550/590(I-P)-2011 conditions and JIS Standard B8621:2011 conditions for temperature and fouling factor of chilled water and cooling water.
2. Max. working pressure (Chilled water and Cooling water): 1 MPa (G)
3. Unit capacity of over 2,700 RT up to 5,400 RT with dual compressors are available.
4. The above specification is not data of max. cooling capacity.
5. Please consult with MTH* in case chiller capacity is more than 800RT with 400V class because it depends motor output.
6. Refer to MTH*'s drawing "MACHINE LAYOUT" and "INVERTER PANEL OUTLINE" at installation.
7. Service clearance must be provided more than above.
8. Shipping weight of inverter panel is approximate weight of standard specification.
9. The above shipping weight of chiller is weight of piece shipment.
10. Design and specifications are subject to change without notice.

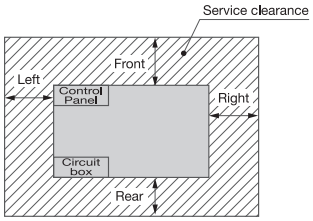
Dimension and Weight

Chiller

Item (unit) \ Model		GART	65 / 65I	75 / 75I	95 / 95I	110 / 110I	135 / 135I	160 / 160I	190 / 190I	225 / 225I	270 / 270I
Dimension	Length (L)	m	4.6	4.6	4.9	4.9	5.5	5.5	5.6	5.7	6.2
	Width (W)	m	2.4	2.4	2.6	2.6	2.9	2.9	3.1	3.2	3.4
	Height (H)	m	2.3	2.3	2.4	2.5	2.6	2.8	3.0	3.1	3.4
Sipping weight		t	10.6	11.5	13.6	15.0	18.7	20.2	23.7	27.4	33.6
Operation weight		t	13.4	14.3	17.5	19.1	24.1	25.6	31.0	35.1	43.9
Service Clearance	Front	m	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
	Both end	m	1.2	1.2	1.3	1.3	1.5	1.5	1.7	1.7	1.9
	Rear	m	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9



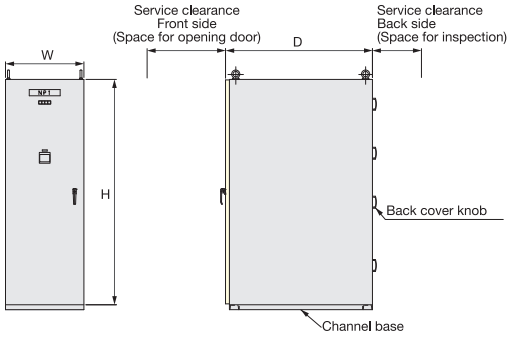




Notes relating to chiller:
1. Service clearance must be provided more than above.
2. Tube removal space must be provided at either end.
3. The piping must be arranged with offsets for flexibility, and adequately supported and balanced independently to avoid strain and vibration transmission on the unit.
4. Prepare the hook for raising compressor and motor unit.
5. The above shipping weight of chiller is weight of 1 piece shipment.
6. Refer to this figure to plan suitable and adequate entrance for machine installation, enough clearance should be provided.
(Caution: This plan shows the size without insulation. After insulation, the size will increase by the thickness of insulator.)
7. Detail other requirement is mentioned in MTH*'s drawing " MACHINE LAYOUT ". Please comply with it.

Starter Panel (GART)

Voltage			400V class	3kV class	6kV class
Dimension	Width (W)	m	0.8	0.8	
	Depth (D)	m	1.2	1.5	
	Height (H)	m	2.35	2.35	
Sipping weight		t	0.6	0.8	
Service Clearance	Front	m	0.8	0.8	
	Back	m	0.5	0.5	
Starting method		-	Star-delta	Reactor (65% TAP) Auto-transformer (65% TAP)	

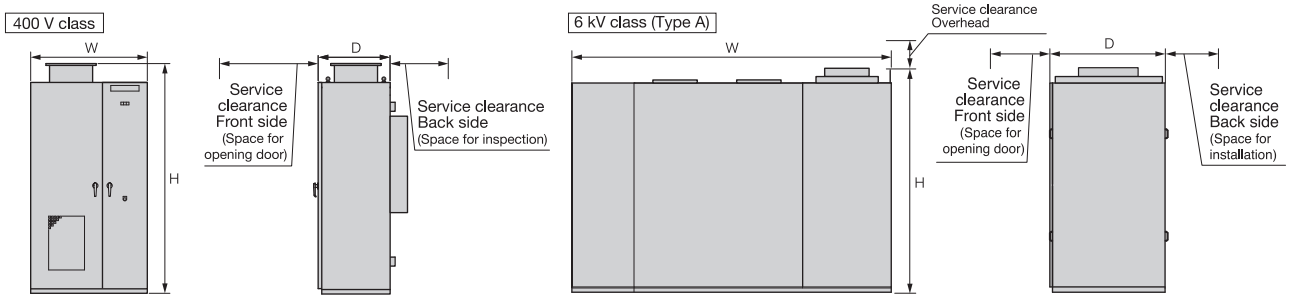


Notes:
1. Refer to MTH*'s drawing "MACHINE LAYOUT" and "STARTER PANEL OUTLINE"at installation.
2. Shipping weight of starter panel is approximate weight of standard specification.
3. Design and specifications are subject to change without notice.

Inverter Panel (GART-I)

Chiller model		GART	65I			75I			95I			110I		135I		160I		190I		225I		270I	
Voltage		-	400V class	6 kV class		400V class	6 kV class		400V class	6 kV class		6 kV class		6 kV class		6 kV class		6 kV class		6 kV class		6 kV class	
Type of inverter panel		-	-	A	B	-	A	B	-	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Dimension	Width (W)	m	1.8	3.7	4.1	2.1	3.7	4.1	2.1	3.7	5.1	4.1	5.1	4.1	5.1	4.1	5.1	4.8	5.1	4.8	5.9	4.8	6.0
	Depth (D)	m	0.8	1.3	0.9	0.8	1.3	0.9	0.8	1.3	0.9	1.4	0.9	1.4	0.9	1.4	1.0	1.5	1.0	1.5	1.0	1.5	1.1
	Height (H)	m	2.6	2.7	2.9	2.6	2.7	2.9	2.6	2.7	2.9	2.7	2.9	2.7	2.9	2.7	2.9	3.0	2.9	3.0	2.9	3.0	2.9
Sipping weight		t	1.1	5.1	4.7	1.4	5.1	5.1	1.4	5.1	6.3	5.5	6.3	5.5	6.3	5.5	7.6	8.0	7.6	8.3	8.7	8.5	9.9
Service Clearance	Front	m	1.1	1.6	1.6	1.1	1.6	1.6	1.1	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.7	1.6	1.7	1.7	1.7	1.7
	Back	m	0.7	0.6	-	0.7	0.6	-	0.7	0.6	-	0.6	-	0.6	-	0.6	-	0.6	-	0.6	-	0.6	-
	Top	m	0.3	0.6	0.7	0.3	0.6	0.7	0.3	0.6	0.7	0.6	0.7	0.6	0.7	0.6	0.7	0.6	0.7	0.6	0.7	0.6	0.7

Notes: 1. MTH* have 2 type inverter panel in 6 kV and 3 kV class. Type A: Small space type for width Type B: Small space type for depth 2. Please contact with MTH* about 3 kV class.



*MTH: Mitsubishi Heavy Industries Thermal Systems, Ltd.

Special Specifications

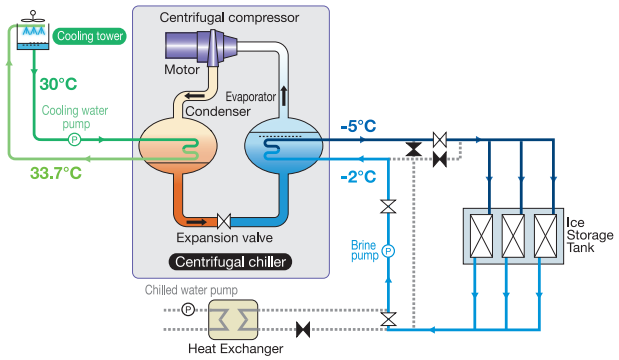
Low Temperature Use

【Brine : Nybrine35%】

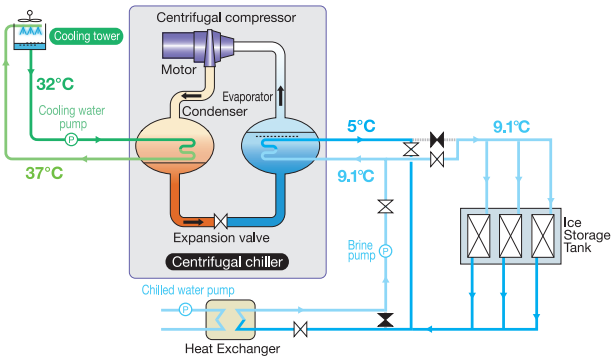
Supply range: GART-65H/65HI ~ 270H/270HI
Please contact MTH* for models not on the following table

Model		GART	65 / 65I		95 / 95I		135/135I		190/190I		270/270I	
Operation mode			Ice charge	Chilled water	Ice charge	Chilled water	Ice charge	Chilled water	Ice charge	Chilled water	Ice charge	Chilled water
Cooling Capacity		RT	410	550	600	800	890	1,190	1,310	1,750	1,490	1,990
		kW	1,442	1,936	2,112	2,816	3,133	4,189	4,611	6,160	5,245	7,005
Motor out put		kW(50Hz)	297	323	421	456	620	682	923	1,022	1,098	1,166
Brine	Entering temp.	°C	-2	9	-2	9	-2	9	-2	9	-2	9
	Leaving temp.	°C	-5	5	-5	5	-5	5	-5	5	-5	5
	Flow rate	m³/h	448.7		656.7		974.1		1,434.0		1,631.0	
	No.of pass	-	2		2		2		2		2	
	Pressure drop	kPa	79	89	140	126	190	172	207	188	101	113
	Piping connection nozle Size	A	250		300		350		400		450	
Cooling water	Entering temp.	°C	30	32	30	32	30	32	30	32	30	32
	Leaving temp.	°C	33.8	37	33.9	37	33.8	37	33.8	37	33.9	37
	Flow rate	m³/h	398.7		574.7		858.5		1,267.0		1,442.0	
	No.of pass	-	2		2		2		2		2	
	Pressure drop	kPa	63	62	53	52	60	59	65	63	64	62
	Piping connection nozle Size	A	250		300		400		450		500	
Voltage		V	400V class / 3kV class / 6kV class				3kV class / 6kV class					

System Flow 【Ice Charge Mode (Night)】



System Flow 【Chilled Water Mode (Day)】



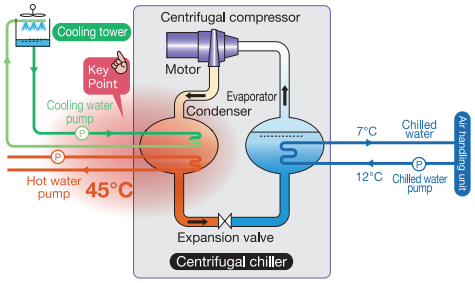
Heat Recovery Use

Chilled water entering temp.: 12°C, Chilled water leaving temp.: 7°C
【Cooling Mode】 Cooling water entering temp.: 32°C, Cooling water leaving temp.: 37°C
【Heat Recovery Mode】 Hot water entering temp. 40°C, Hot water leaving temp.: 45°C

Supply range: GART-65H.HR/65H.HR.I ~ 270H.HR/270H.HR.I
Please contact MTH* for models not on the following table

Model		GART	65 / 65I		95 / 95I		135/135I		190/190I		270/270I	
Operation mode			Cooling	Heat recovery	Cooling	Heat recovery	Cooling	Heat recovery	Cooling	Heat recovery	Cooling	Heat recovery
Cooling Capacity		RT	580	580	760	760	1,220	1,220	1,610	1,610	2,260	2,260
		kW	2,039	2,039	2,672	2,672	4,290	4,290	5,661	5,661	7,947	7,947
Heating capacity		kW(50Hz)	-	2,455	-	3,213	-	5,148	-	6,799	-	9,588
Motor output		kW(50Hz)	309	382	399	495	647	795	847	1,052	1,209	1,503
Chilled water	Flow rate	m³/h	349.9		458.5		736.0		971.3		1,363.0	
	No.of pass	-	2		2		2		2		2	
	Pressure drop	kPa	49	49	53	53	83	83	75	75	70	70
	Piping connection nozle Size	-	250		300		350		400		450	
Cooling water /Hot water	Flow rate	m³/h	412.5	426.9	539.8	558.7	865.9	895.2	1,142.0	1,182.0	1,609.0	1,667.0
	No.of pass	-	2		2		2		2		2	
	Pressure drop	kPa	69	65	49	48	63	61	55	54	80	78
	Piping connection nozle Size	-	250		300		400		450		500	
Voltage		V	400V class / 3kV class / 6kV class				3kV class / 6kV class					

System Flow 【Heat Recovery Mode】



Scope of Supply

○: Standard scope of supply　△: To be supplied as option
×: Not within scope of work of supply　—: Not available

Item		Specifications	GART	GART-I
Equipment	Chiller Assembly	Indoor type (including control panel)	○	○
		Outdoor type (including control panel)	△	△
	Compressor	Hermetic, two-stage, centrifugal type	○	○
	Compressor Motor	Liquid refrigerant cooled, hermetic, squirrel cage, 3-phase, induction type motor, 2 pole, insulated grade B	○	○
	Step-up Gear	Integrated inside compressor housing, single helical gear	○	○
	Lubrication System	Trochoid pump with submerged motor, refrigerant cooled oil cooler, single oil filter, oil heater with temperature control	○	○
		Double oil filter	△	△
	Evaporator & Condenser	Japanese High Pressure Gas Safety Law and JIS	○	○
		Horizontal shell and tube type with copper tube (3/4"OD) Design pressure of water box: 1.0 MPa (G)	○	○
		Marine type water box with hinge	○	○
		Tube material other than copper (ex: cupronickel, admiralty brass, titanium)	△	△
		Tube sheet material other than steel (ex: naval brass clad steel, titanium clad steel)	△	△
		Design pressure of water box: Over 1.0 MPa (G)	△	△
	Safety Device	High condensing pressure, Low evaporating pressure, Low oil pressure, Low chilled water outlet temperature, Low chilled water flow rate, Low cooling water flow rate, High oil temperature, High compressor motor coil temperature, Low voltage, Compressor motor over load	○	○
	Microcomputer Control Panel	Mounted on heat exchanger, indoor non hazardous type with color liquid crystal display, lamps and control switches on microcomputer operation board Prepare 200/220 V three-phase as an auxiliary power. In case of other voltage, consult with MTH*.	○	○
	Starter Panel(GART) Inverter Panel(GART-I)	Self standing, indoor, non hazardous type with a multi meter	○	○
		Self standing outdoor, hazardous type with a multi meter	△	—
		Starting method 【low voltage】 Star-delta, 【high voltage】 Reactor	○	—
		Starting method 【low voltage】 Reactor, Auto-transformer, Direct on line Starting, 【high voltage】 Auto-transformer, Direct on line	△	—
		Starting method 【low/high voltage】 Inverter	—	○
		Installer Breaker　GART：ELCB of low voltage. PF of high voltage, GART-I: ELCB of low voltage. VCB of high voltage	○	○
		Capacitor for power factor improvement	△	—
		400 V class for compressor motor (more than 800RT)	△	△
		10, 11 kV/50 Hz power for compressor motor	△	—
		Tie transformer for control power (ex: 400/200 V)	△	△
	Refrigerant	HFC134a in pressure bottles for one (initial) charge	○	○
	Lubrication Oil	Ester oil in can for one (initial) charge	○	○
	Accessory	A thermometer of oil reservoir, Sight glasses, Pressure gauges of condenser, evaporator and oil pressure, Rubber pad of vibration isolating, Special insulation tape of compressor motor terminal, Flow switch of chilled water and cooling water	○	○
		Foundation bolt	△	△
		Spring pad for vibration isolating	△	△
		Charging hose for refrigerant	△	△
		General tool and tool box	△	△
	Spare Parts	An oil filter element, A filter drier, A fuse for control panel	○	○
Test	Shop Test	Test in accordance with JIS B8621	○	○
		Test in accordance with AHRI 550/590	△	△
	Witness Test	Witness test at manufacture's (MTH*) site	△	△
Painting	Chiller	Rust preventing paint (two coat)	○	○
		Finish coat	△	△
	Control Panel	Rust preventing and finish coat (color: Munsel 5Y7/1)	○	○
	Starter Panel(GART)/Inverter Panel(GART-I)	Rust preventing and finish coat (color: Munsel 5Y7/1)	○	○
Insulation of Chiller		Not provided (Purchaser's scope. Instruction for insulation to be submitted.) Please follow our INSULATION PROCEDURE.	—	—
		Polystylen form covered by Colored steel sheet 0.3 mm	△	△
Delivery		FOB Kobe port in Japan	○	○
		Ex warehouse at Kobe port in Japan (on truck)	△	△
		CIF port near Site	△	△
Shipping Style of Chiller		Integrated style	○	○
		Divided style	△	△
Site Works	Foundation	Customer's scope	×	×
	Installation	Chiller installation, setting of anchor bolt, water pipe and piping works, and cable and wiring works at site	△	△
		Supervisor for site installation	×	×
	Commissioning	Supervisor for site commissioning	△	△
Others	Code and Standard	JIS (Japan Industrial Standard), JEC (Japanese Electrotechnical Committee), JEM (The Standard of Japan Electrical Manufacture's Association)	○	○
		DOSH (Malaysia), MOM (Singapore)	△	△
		ASME ASTM	—	—
	Capacity Control	100-20%, Controlling compressor inlet guide vane (1st & 2nd stage) and hot gas bypass valve	○	○
		100-10%, Larger hot gas bypass valve than standard	△	△
		100-0%	×	△
	Restart after instantaneous power failer		△	△
	Control Interface	Interface and communication to Building Control System	△	△
	Drawings	Specification and scope of supply	○	○
		General arrangement (including foundation)	○	○
		Outline of control panel	○	○
	Documents	Sequence diagram	○	○
		Operation and maintenance instruction	○	○
		Performance test report	○	○

*MTH: Mitsubishi Heavy Industries Thermal Systems, Ltd.

Option

Variable Over Water Flow System

- In the case of the multiple constant speed chillers' operation such as a district cooling system plant and a large capacity system, the cooling demand may be little depending on the season or time of operation. In such a case, multiple chiller units which can expense the cooling demand or more should be operated to secure the supplying chilled water flow rate. Therefore, each chiller is operated in the low load area in which the COP is low. In addition, the number of starting coolingand chilled water pumps is increased and the COP of the whole chiller system decreases. For the variable over water flow system, the chiller and water pump are designed to have an availability of chilled water flow rate more than the rated value. This design suppresses the number of starting chiller auxiliaries including chiller and water pump and secures the cooling water flow rate. Moreover, by suppressing the number of starting chillers, the load of each chiller is increased and it is capable of operating the chillers at the load point in which the COP is relatively high. Then, the COP of the whole system is improved.Figure 1and 2 show the operating simulation of this system.※If the variable over water flow system is not adopted, it is required to start three chillers and those auxiliaries to secure 1,210 m³/h chilled water flow rate. (Figure 1) Accompanying with the increase of the chilled water flow rate, each chiller is started one by one and the COP of the whole system decreases at each time. (Figure 2) This is caused because each chiller must be operated at low load (cooling demand / the number of chiller units).When the variable over water flow system is adopted, it is capable of securing 1,210 m³/h chilled water flow rate by starting only one over flow control chiller. This chiller operates at the load equivalent to the cooling demand and makes it possible to operate at a higher COP, comparing to the chiller without this system under the same condition.

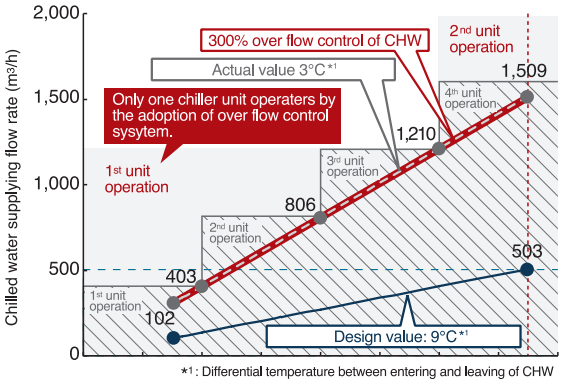


Figure 1
Suppression of the Number of Operating Chiller Units by Over Flow Control

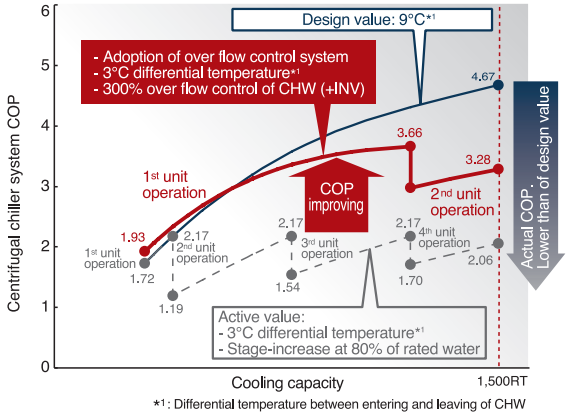


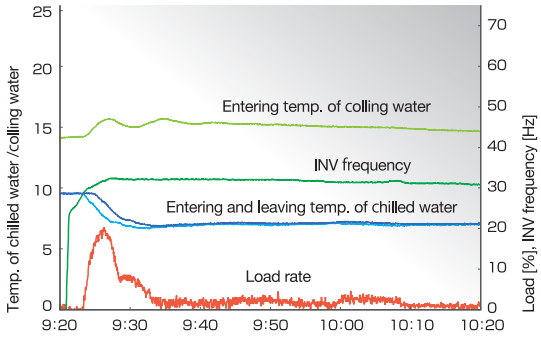
Figure 2
Improvement of Centrifugal Chiller System COP by Over Flow Control

Notes: -Rated chilled water flow rate is 503 m³/h or 403 m³/h (80%) for operating multiple chiller units.
-Only one chiller unit operates by the adoption of over flow control system (300%).

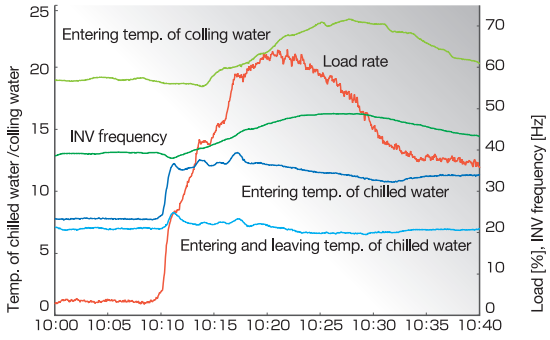
Extreme Low Load Operation

Notes: Option of Variable Speed Drive GART-I

- The temporary boiler for initial trial operation of cooling plant will be unnecessary
- Stand by operation will still be possible even in expected rapid cooling load rise.
- Reduces fluctuation of chilled water supply temperature at sudden cooling load changes, therefore continuous operation will still be possible.



Status trend graph for 0% load operation <Reference data>



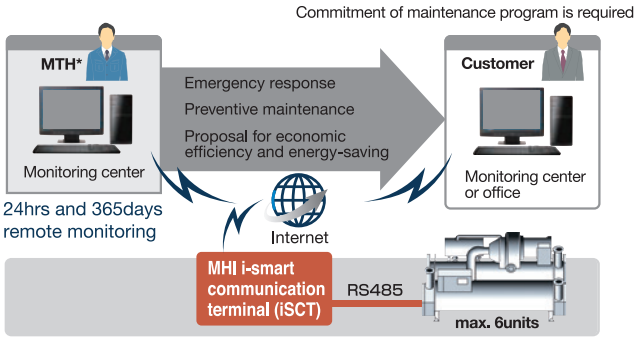
Startup characterostocs from standby operation <Reference data>

Instantaneous Power Failure Restart

- Possible to restart operation automatically, if the instantaneous power failure time is within set value
  Initial set value of instantaneous power failure time is as follows.

- Standard Option : 2 seconds
- Special Option : abailable to extend up to 3600 seconds by changing the parameter

Remote Monitoring Program (WEB communication)

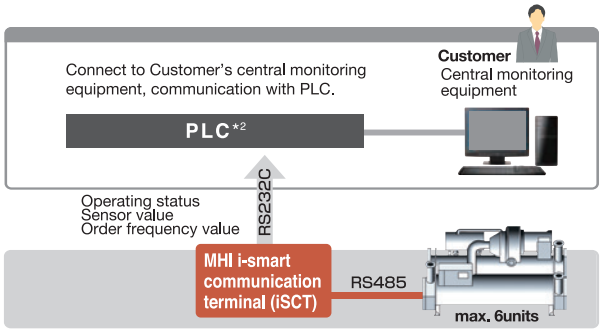


Notes: Cable connection work between chiller and iSCT: customer's scope

24-hour and 365-day remote monitoring program is suitable for maintaining the performance and function of the centrifugal chiller.

Features
The remote monitoring program enables various performances.
1) Monitoring the operation status
2) Emergency response/treatment and report of the result
3) Submission of monthly report of data and customer's observation
4) Proposal for preventive maintenance and economical use based on the result of the analysis of accumulated data
This program is not available for poor quality internet connections environment.

Central Monitoring



*2 PLC: MELCO MELSEC or Modbus

Features
1) Output operation data at customer's central monitor through MHI i-smart communication terminal.
2) Operation data can be used for the following items at customer's central monitor.
- Trend
- Operation status of chillers
- Daily report and monthly report etc.
3) Total connection/transmission distance of RS485 with max. 500 m

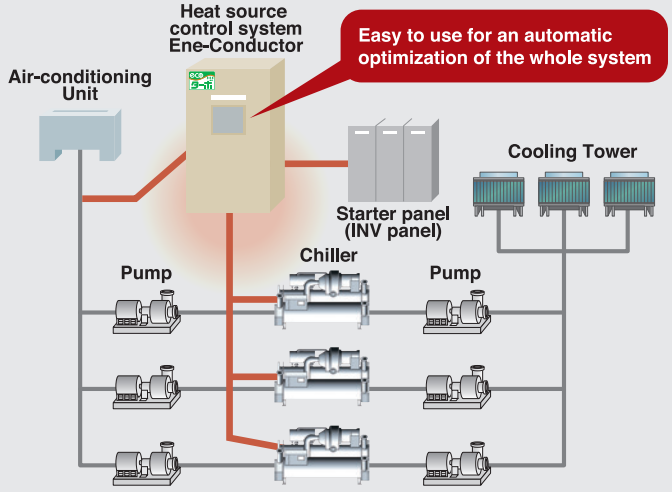
Feature of MHI specialized communication terminal

Compact size (W317 x H78 x D265 mm: excluding projection portion)
Connected to AC 100 V plug
High speed data processing by 32 bit CPU

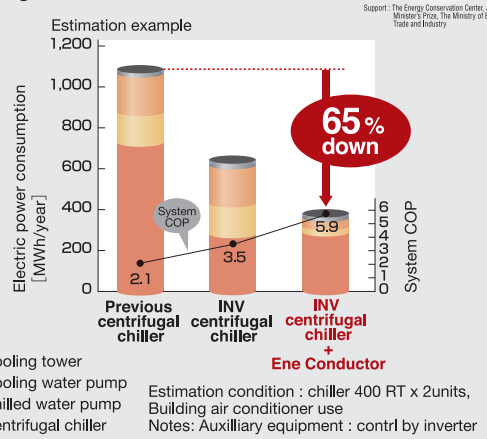
More Energy saving

Heat Source Control System
Ene-Conductor

- Improvement of system COP by optimal control which gets the best perfomance out of centrifugal chiller
- Various energy-saving control functions

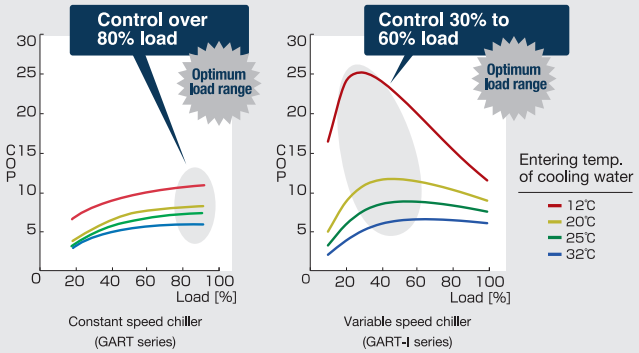


- **Improvement in COP of centrifugal chiller**
- **Chilled water variable flow control**
- **Cooling water variable flow control**



Estimation condition : chiller 400 RT x 2units, Building air conditioner use
Notes: Auxilliary equipment : contrl by inverter

Control functions of Ene-Conductor



■ Optimize load distribution and operation number

In the case where the system combines multiple chillers with different performance, the Ene-Conductor automatically calculates the best load for each chiller to obtain the highest COP of the complete system.

- **Multiple chiller control**
- **Chilled / hot water variable flow rate control (Primary pump)**
- **Cooling water variable flow rate control**
- **Cooling tower operation/ fan control**
- **Coolling water bypass valve control**
- **Chilled / hot water bypass valve control**
- **Chilled / hot water secondary pump control**

*MTH: Mitsubishi Heavy Industries Thermal Systems, Ltd.

Our factories are ISO9001 and ISO14001 certified.

Certified ISO 9001

Certificate number: JQA-0709
Date of certificate: December 16, 1994

Registration number: 02115Q10571R0S
Date of certificate: May 21, 2015

Certified ISO 14001

Certificate number: YKA4005636
Date of certificate: December 27, 2017

Registration number: 02115E10252R0S
Date of certificate: May 21, 2015

www.mhi-mth.co.jp/en/

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